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Body-Mass Index and Mortality Risk in US Blacks Compared to Whites

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Abstract

Objective—To compare body-mass index (BMI)-related mortality risk in US Blacks vs. Whites as the relationship appears to differ across race/ethnicity groups.

Design and Methods—We pooled cross-sectional surveys of nationally representative samples of 11,934 Blacks and 59,741 Whites aged 35–75 in the National Health Interview Survey from 1997–2002 with no history of cardiovascular disease or cancer. Mortality follow-up was available through 2006. BMI was calculated from self-reported height and weight. We used adjusted Cox regression analysis to adjust for potential confounders.

Results—Over 9 years of follow-up, there were 4,303 deaths (1,205 among never smokers). Age-adjusted mortality rates were higher in Blacks compared to Whites at BMI < 25 kg/m^2 and showed no increase at higher levels of BMI. In men, adjusted hazard ratios for all-cause death rose in a similar fashion across upper BMI quintiles in Blacks and Whites; in women, however, BMI was positively associated with mortality risk in Whites, but inversely associated in Blacks (p interaction = 0.01). Racial disparities were amplified in subsidiary analyses that introduced a 12-month lag for mortality or focused on CVD mortality.

Conclusions—The relationship of elevated BMI to mortality appears weaker in US Blacks than in Whites, especially among women.

Keywords

Body Mass Index; Mortality; Racial/Ethnic Health Disparities

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INTRODUCTION

In non-smoking adults of European ancestry, body-mass index (BMI) above 25 kg/m^2 is consistently associated with elevated mortality risk (1). The BMI-mortality relationship is less consistent in non-white populations. For example, the relationship appears to be weak or even flat in Asian Indians and Bangladeshis (2).

Data on BMI-related risk in US Blacks are mixed. Compared to Whites, BMI in Blacks appears to be less strongly associated with body fat, dyslipidemia, and metabolic syndrome (3). Likewise, epidemiologic studies suggest that the relationship between BMI and all-cause mortality may be weaker in Blacks compared to Whites (4–15). In contrast, a recent nationwide cohort study of black women demonstrated a graded mortality risk, but the cohort was not designed to be nationally representative and over-sampled more educated women (16). If the BMI-mortality relationship were indeed weaker in Blacks, current recommendations regarding optimal BMI in Blacks might require modification upon reviewing disease incidence and mortality data.

We hypothesized that the BMI-mortality relationship is weaker in Blacks than in Whites. To test this hypothesis, we analyzed mortality data from a nationally representative cohort of 59,741 White and 11,934 Black adults aged 35 to 75.

METHODS

The National Health Interview Survey

We used nationally representative survey data from the National Health Interview Survey (NHIS). NHIS uses a three-stage stratified cluster probability sampling design to conduct annual face-to-face health interviews of non-institutionalized US civilians. A complete description of NHIS procedures is available elsewhere (17).

The survey interviews were conducted using computer-assisted personal interviewing (CAPI). After enumerating all the members of the household, the following data were collected on every member: socio-demographic characteristics, medical history, activity limitations, injuries, health insurance coverage, and access to and use of health care services. Within each family in a household, one child (not included in this analysis) and one adult (the focus of this analysis) were randomly selected to provide more extensive health-related information. We used NHIS data pooled from 1997 to 2002 by the Integrated Health Interview Series with links to the National Death Index (NDI) up to December 31, 2006 (18). The average response rate for the randomly sampled adults over the study period was 73.7% (range: 71.1–78.1%).

Our study was approved by the Institutional Review Board's Committee on Human Research at the Johns Hopkins Bloomberg School of Public Health and the NHIS received informed consent from each participant.

Study participants

Our sample included participants who were between 35 and 75 years old who were Non-Hispanic White or Non-Hispanic Black (henceforth, White or Black) based on self-report. We excluded individuals if they met any of the following conditions: 1) were born outside the US; 2) reported a prior history of cancer and/or heart disease (to minimize the influence of reverse causation); 3) were pregnant at time of interview; 4) had missing data on height, weight, mortality, heart disease, cancer, or smoking status; or 5) had a body-mass index (BMI) <15 or >55 kg/m^2. After exclusions, our final sample consisted of 71,675 participants (see Figure 1). We compared analysis-eligible NHIS participants with complete data vs.

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their counterparts with missing data and found no significant differences in age, sex, race, health status, poverty status, or household size.

Measures

All-cause mortality—Our main outcome of interest was all-cause mortality. Deaths were identified by linking NHIS to the National Death Index (NDI), and International Classification of Disease (ICD)-10 codes were used. The NDI is a computer database of all deaths in the US since 1979 with a high level of death ascertainment (19). The matching methodology employed in linking NHIS and NDI is a modification of probabilistic approaches and was performed by the National Center for Health Statistics (NCHS). This procedure identifies 93% of deaths.

Only participants with sufficient data to be eligible for mortality follow-up were included in the study and multiple sources of death information (e.g. NDI death certificate, Social Security Administration, Center for Medicaid and Medicare Services) were used for matching; if there was no linkage with death by the end of the study period, the participants were assumed to be alive.

Body-Mass Index—Using the entire analytic sample of participant-reported heights and weights, we classified participants into BMI quintiles, rounded to the nearest 0.5 BMI unit. Quintile 1 represented BMI < 23.0 kg/m^2; quintile 2: BMI 23.0–24.9 kg/m^2; quintile 3: BMI 25.0–27.4 kg/m^2; quintile 4: BMI 27.5–30.9 kg/m^2; and quintile 5: BMI ≥ 31.0 kg/m^2. Standardized categories based on WHO organization categorizations were also employed for more straightforward comparisons.

Covariates—Covariates selected *a priori* as potential confounders included age (as the timescale), smoking, alcohol consumption, leisure-time physical activity, educational attainment, and marital status. We did not attempt to adjust for potential mediators of the association between BMI and mortality (e.g. hypertension and diabetes mellitus). Cigarette smoking status was categorized as ever or never, and alcohol consumption as current, former or never. Leisure-time physical activity was categorized as none, low, or high based on the participant's answer to the following two questions: (1) 'How often do you do light or moderate leisure-time physical activities for at least 10 minutes that cause only light sweating or a slight to moderate increase in breathing or heart rate?' and (2) 'How often do you do vigorous physical activities for at least 10 minutes that cause heavy sweating or a large increase in breathing or heart rate?' Participants who answered 'never' or 'unable to do this type activity' were classified as 'none.' Participants who engaged in at least some level of activity and provided a specific number of activity bouts were classified as either "low" or "high" using the median (i.e. 9 bouts of moderate and 5 bouts of vigorous activity) as the cut point.

Educational attainment was categorized as low (no high school diploma), medium (high school or general equivalency diploma), and high (higher than a high school diploma). Marital status was categorized as either married; divorced, widowed, or separated; or never married.

Statistical Analysis

We used sampling weights to account for the unequal probabilities of selection resulting from the sample design, from non-response to the NHIS, and from planned oversampling of Hispanic, Non-Hispanic Black, Non-Hispanic Asian and the elderly (65 years or older). Standard errors or variance estimations were calculated using Taylor series linearization. The "subpop" command in STATA version 10 (STATA Corporation, College Station,

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Texas, USA, 2007) was used for correct variance estimation using the analytic sample. A two-sided p-value < 0.05 was considered statistically significant.

We compared Blacks and Whites across BMI quintiles for sociodemographic characteristics, self-reported medical history, health behaviors, and all-cause mortality. Continuous variables were expressed as means (standard error). Distributions of categorical variables were presented using estimated population percentages. To test for differences in pre-specified sociodemographic, clinical, and behavioral characteristics between Whites and Blacks, we used the Rao-Scott second-order-corrected Pearson statistic for complex survey data (20).

We stratified all mortality analysis by smoking status (ever vs. never), since smoking is well known to increase mortality risk while decreasing body weight. We focused mainly on never smokers for that reason.

Using the age distribution from the 2000 U.S. Census as the standard population, we used the direct adjustment method to calculate age-standardized death rates for BMI quintiles associated with each race-sex group. We computed rate ratios by dividing the sex-specific death rate for Blacks in each BMI quintile by the corresponding rate for Whites in the same quintile. Rate differences were computed by subtracting the sex-specific death rate for Blacks in each BMI quintile from the corresponding rate for Whites.

To calculate race-sex-specific excess death rates, BMI quintile 2 (23.0–24.9 kg/m^2) was used as the reference category. We first subtracted deaths in the reference category from each BMI quintile for each specific race-sex group. To calculate sex-specific excess death rates, we subtracted deaths in the reference category from Whites in each BMI quintile.

We used Cox proportional hazard regression models to assess the race-sex specific hazard ratio of all-cause mortality across BMI quintiles. The proportional hazards assumption of the model, tested using Schoenfield residuals, was met.

Follow-up time for the analyses was counted from age at enrollment to either age of death or, if classified as alive, then age at the end of the study period (31 December 2006), or age 75—whichever was lowest. Age in years was used as the timescale in proportional hazard modeling.

We conducted three subsidiary analyses with limited power: 1) for mortality related to cardiovascular disease, cancer, and other less common causes; 2) for a possible interaction between educational attainment and mortality risk within race-sex groups and 3) after excluding deaths within the first 12 months to reduce the likelihood of reverse causality.

We also conducted sensitivity analyses using a multiple imputation approach to correct for potential impacts of covariate measurement errors in self reported BMI (21). The mean model for imputing the measured BMI was developed using measured and self-reported BMI data from the NHANES collected in 1999 to 2002, following a similar approach by Stommel & Schoenborn (22), which resulted in a model accounted for 93% of the variability in measured BMI. Ten sets of measured BMI were imputed and similarly analyzed, with results combined using standard multiple imputation approach, to examine the robustness of the finding based on self-reported BMI.

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RESULTS

Characteristics of the study sample

Sociodemographic, clinical and behavioral characteristics of the 32,975 never-smokers without a history of heart disease or cancer are shown by BMI quintile at baseline in Table 1. As expected, adults with higher BMI were more likely to be Black, to have less education, to be physically inactive, and to have diabetes and hypertension. Similar trends prevailed among ever smokers, except for education (Table 2).

Among never smokers, we found expected racial disparities (Table 3). Compared to their White counterparts, Blacks had less education, were less likely to have married, were more likely to have diabetes and hypertension, were more likely to be physically inactive, and had higher BMI.

Black-White Comparison of the BMI-Mortality Relationship

During 9 years (median 6; mean 6.4) of follow-up from 1997 to 2006, corresponding to 212,349 person-years, there were 4,303 deaths: 3,321 in Whites and 982 in Blacks.

Age-standardized all-cause mortality rates for never and ever smokers by sex and BMI quintile are illustrated in Figure 2. Among both never and ever smokers, mortality rates were higher among Blacks compared to Whites, especially at BMIs < 25 kg/m^2. In Blacks, mortality rates appeared higher in quintile 2 (23.0 – 24.9 kg/m^2) than in quintile 5 (31.0 – 55.0 kg/m^2). In Whites, however, mortality rates appeared higher in quintile 5 than quintile 2, except in male ever smokers.

We found similar patterns for sex-specific excess deaths (Table 4). Excess deaths in Black men (compared to White men) appeared higher in BMI quintiles 1 and 2 than in quintile 5. Excess deaths in Black Women (compared to White women) appeared higher in BMI quintiles 1 and 2 than in quintiles 4 or 5. The data is also displayed by standard BMI categories (Supplementary Table 1).

Figure 3 displays fully adjusted hazard ratios for all-cause mortality by BMI, race and sex. Low BMI (< 23.0 kg/m^2) was independently associated with higher mortality rates in all 4 race-sex groups compared to quintile 2 (23.0 – 24.9 kg/m^2) as the referent. In never smoker White women, BMI in excess of 25.0 kg/m^2 was associated with greater mortality in a graded fashion. In white men, the relationship was flatter, but still statistically significant ($p = 0.03$) for quintile 5 (31.0 – 55.0 kg/m^2) compared with quintile 2 (23.0 – 24.9 kg/m^2). The adjusted risk pattern in Black men was similar to that of their White counterparts. In nonsmoking Black women, however, the relationship of BMI to mortality was inverse above 23.0 kg/m^2 and significantly different from the relationship in nonsmoking White women (p for interaction = 0.01).

Subsidiary Analyses

We conducted three fully adjusted subsidiary analyses to confirm the robustness of our main results. First, the Black-White contrast in risk patterns was heightened after excluding deaths in the first 12 months of follow-up (Figure 4). Second, the contrast was also amplified when we limited the outcome to cardiovascular disease (CVD) mortality (Supplementary Table 2). In this analysis, the BMI-mortality relationship was strongly positive in White men and strongly negative in Black men (p for interaction < 0.001). Finally, in a pre-specified analysis prompted by the results of the Black Women's Study (16), we found interactions between educational attainment and the BMI-mortality relationship: in White and Black women and in White men, lower educational attainment was associated with an inverse

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relationship between BMI and mortality (Supplementary Figure 1). Positive associations between BMI above 23.0 kg/m^2 and mortality appear limited to individuals with at least a high school education. Correcting for potential self-reporting errors in sensitivity analyses did not meaningfully alter the risk patterns across BMI quintiles among race and sex groups (Supplementary Figures 2 and 3).

DISCUSSION

These data suggest that the relationship of body-mass index to mortality risk is weaker in US Blacks than in Whites, especially in women. The racial contrast in the BMI-mortality relationship was present in never smokers without a history of heart disease or cancer, was stronger when limited to cardiovascular disease mortality, and was stronger when excluding deaths in the first 12 months of follow-up. Compared to prior studies of BMI and mortality risk in Blacks, our study had four main strengths: 1) a nationally representative cohort; 2) comparable data on Black and White men and women that allowed a direct comparison of risk patterns; 3) more recently collected data; and 4) measurement error corrected estimates.

Since 1980, at least 18 published studies of BMI and mortality have included data on US Blacks (4–11, 13–16, 23–27). Ten studies included Black and White men and women from the same study sample (5–7, 9–11, 23, 24, 26, 28), 2 studies reported the BMI-mortality relationship among Blacks only (15, 16), 3 studies compared Black-White BMI-mortality relationships in women only (5, 13, 14), and 1 in men only (29). Fifteen of the 18 studies reported a weaker BMI-mortality relationship in Blacks vs. White women (4–7, 9–11, 13–15, 23, 24, 26, 28), and 11 a weaker relationship in Black vs. White men (5–8, 10, 11, 23–28). A review conducted in 2000 also concluded that the elevated BMI-mortality association was weaker in Black compared to White women (29).

The strongest evidence favoring a positive BMI-mortality relationship in Blacks comes from the Black Women's Health Study (BWHS) (16). We used a nationally representative sample of Black women, whereas the BWHS which recruited participants via college sororities, professional organizations, and magazine subscription lists, producing a convenience sample of whom 44% had completed college. In BWHS, the positive finding was limited to women who had attended college; there was no relationship between BMI and mortality in women who had not attended college. In our nationally representative cohort, the inverse relationship of BMI to mortality was strongest, in absolute terms, in black women who had not graduated high school. Low educational attainment also appeared to efface the positive BMI-mortality relationship in Whites. Thus, convenience samples might hide important interactions between socioeconomic status and BMI in regards to mortality risk.

Most large-scale studies of BMI and mortality rely on self-reported height and weight for convenience. An exception is the NHANES Mortality Study, which uses measured height and weight (7). Perhaps not incidentally, NHANES has generally found weaker associations between BMI and mortality in the general population than have other cohort studies with convenience samples and self-report data (7, 8, 24). Most studies have concluded that Blacks and Whites do not self-report their height and weight differently (30–35) while some have reported small differences (22, 36, 37), including a tendency for more educated Black women to under-report body weight more than other race-sex-education groups (38).

If the elevated BMI-mortality relationship in U.S. Blacks, especially Black women is weaker than in their White counterparts, what might explain the difference? First, BMI may be a weaker indicator of adiposity in Blacks (39). Second, at the same level of adiposity, fat distribution may be more favorable in Blacks (39). Third, BMI in Blacks is less strongly associated than in Whites with dyslipidemia—an important risk factor for cardiovascular

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disease (3, 26). Fourth, Black women may have greater chances of preclinical and undiagnosed chronic diseases that may lead to weight loss, thereby enhancing the probability of reverse causation. Fifth, BMI may pose a smaller obstacle to some health behaviors in Black vs. White women. For example, increasing BMI is strongly associated with a lower likelihood of undergoing routine mammography in White, but not Black women (40).

How should the higher background mortality in Blacks, specifically in the reference group (quintile 2, BMI 23.0 – 24.9 kg/m^2), influence our interpretation? Higher mortality at lower BMI must of course drive the weaker or inverse risk patterns in Blacks. But if BMI were positively associated with mortality in Black women, then rates should rise further with BMI. Or if the BMI signal were too weak in the presence of higher background mortality, then rates should remain steady or rise subtly in Black women. We did not observe such patterns.

We conclude that the BMI-Mortality relationship appears weaker among Blacks compared to Whites, especially among women—a finding that is consistent with the bulk of prior mortality literature. We believe that these data support a careful reconsideration of current BMI recommendations for US Blacks understanding that recommendations are largely based on incidence rather than mortality data.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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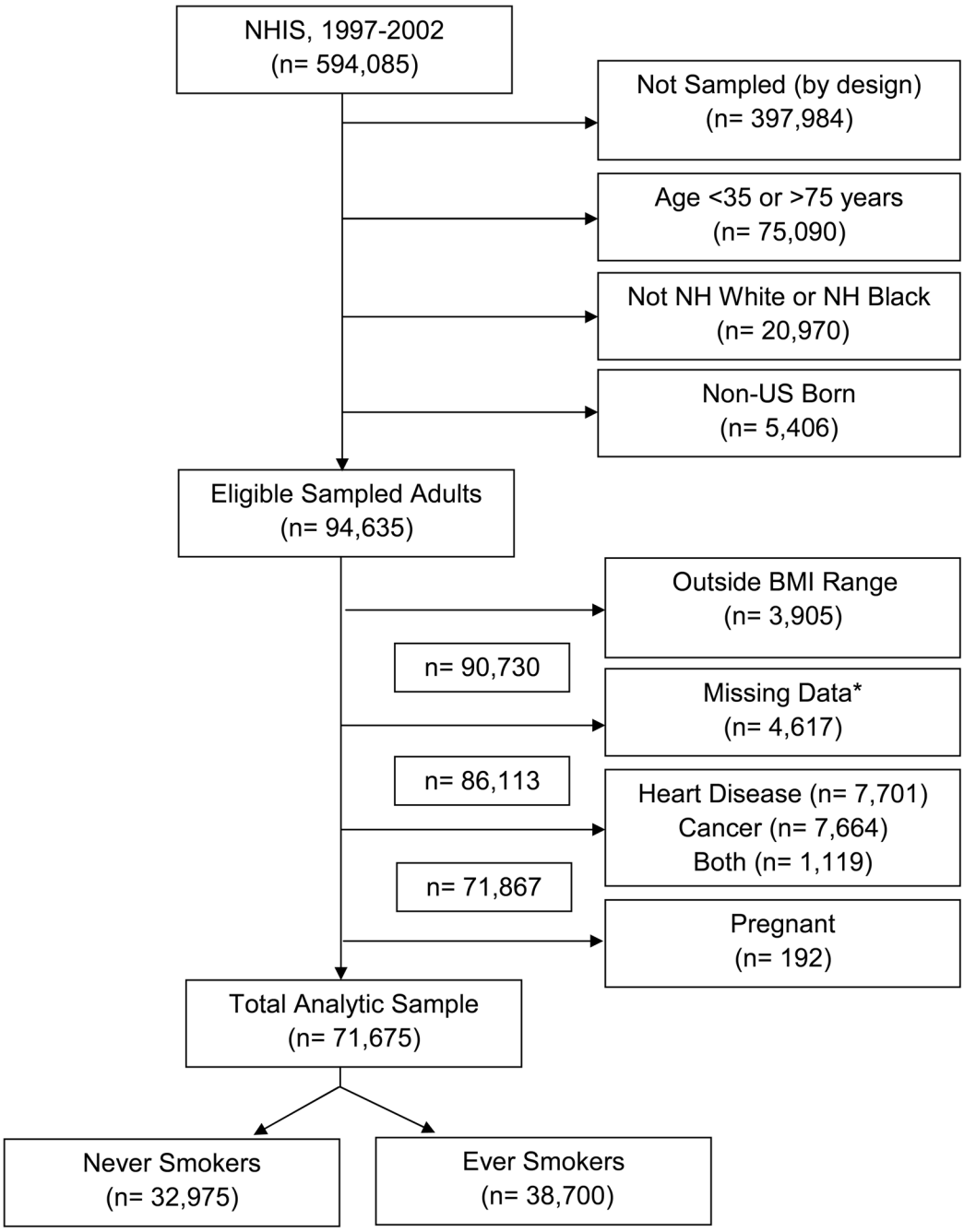

Figure 1. Composition of the Analytic Sample

NHIS=National Health Interview Survey from 1997 to 2002 with mortality follow-up until 2006; NH=Non-Hispanic; *Missing data on smoking, cancer, heart disease, or mortality status; All participant characteristics have less than 10% missing values. Not sampled=not randomly selected to participate in sample adult file that has more extensive health data than family file

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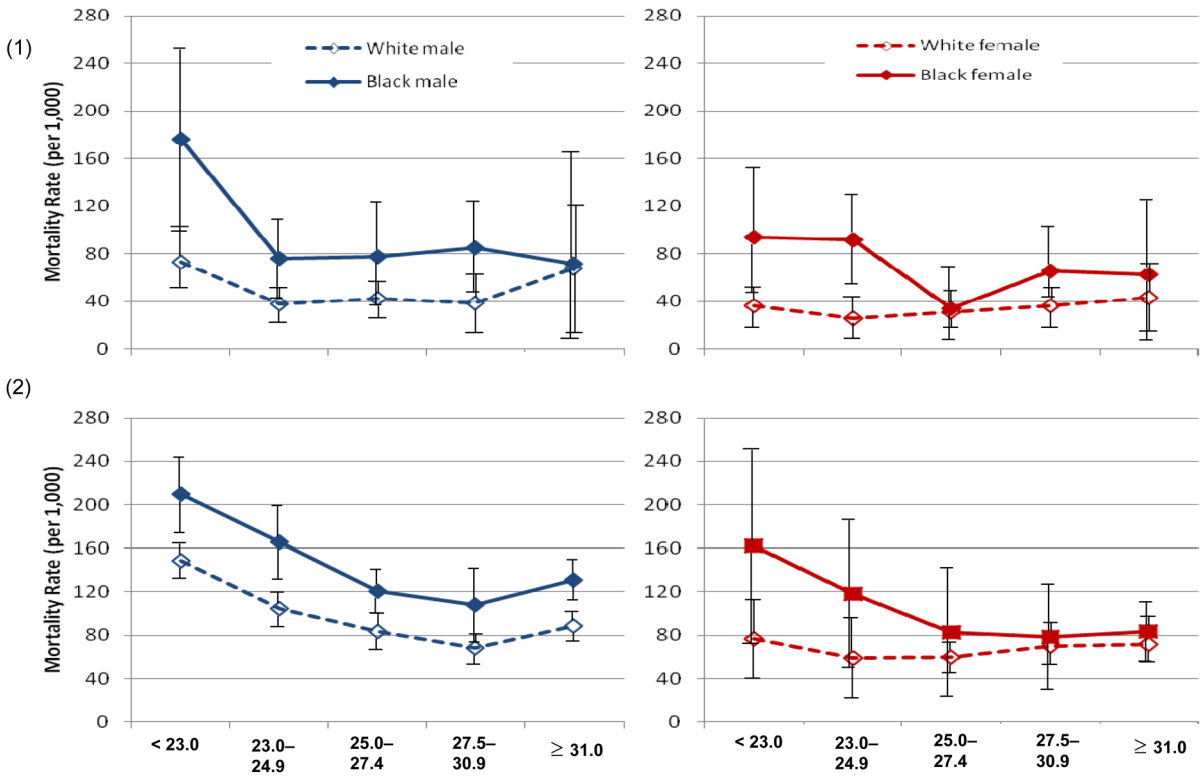

Figure 2. Age-standardized All-Cause Mortality Rates (per 1000 person-years) through 2006 for (1) 32,975 Never Smokers and (2) 38,700 Ever Smokers Aged 35 to 75 Years without a History of Heart Disease or Cancer at Baseline, by Race, Sex, and Body-Mass Index Quintile

Bars indicate upper or lower 95% confidence intervals.

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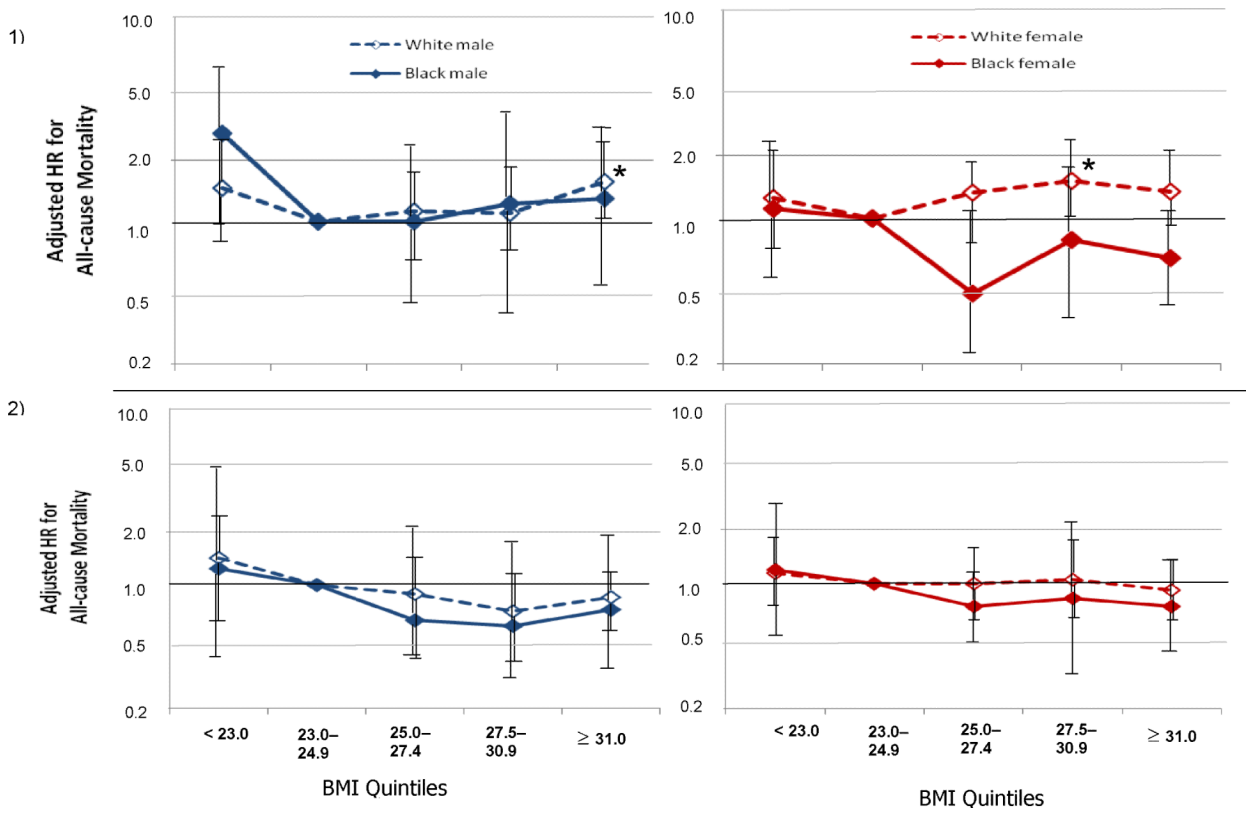

Figure 3. Adjusted Hazard Ratios for Death from Any Cause among 1) 32,975 Never Smokers and 2) 38,700 Ever Smokers Aged 35 to 75 without Heart Disease or Cancer at Baseline by Race, Sex, and Body-Mass Index Quintile

Error bars indicate upper or lower 95% confidence intervals

Hazard ratios were obtained using Cox proportional hazards models adjusted for age (as the timescale), alcohol consumption, leisure-time physical activity, educational attainment (less than high school, high school, some college, college or more), and marital status.

Each race-sex specific group uses its respective quintile 2 as the reference

*Indicates $p<0.05$ for comparison to quintile 2 for each separate race-sex group

p for linear trend for quintile 2 through quintile 5: 0.09 (White men) and 0.25 (White women)

p for Race-BMI

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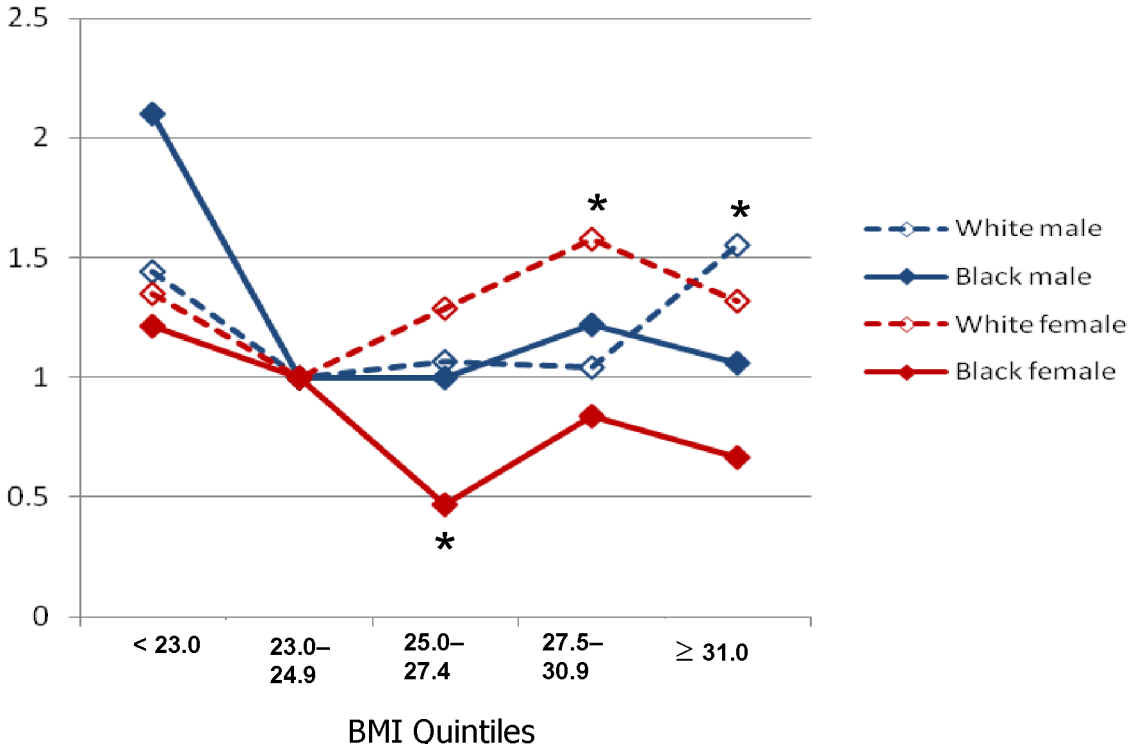

Figure 4. Adjusted Hazard Ratios for All-Cause Mortality (Censoring Deaths in the First 12 Months of Follow-Up) in 32,975 Never Smokers Aged 35 to 75 without Heart Disease or Cancer by Race, Sex, and Body-Mass Index Quintile

Hazard ratios were obtained using Cox proportional hazards models adjusted for age (as the timescale), alcohol consumption, leisure-time physical activity, educational attainment (less than high school, high school, some college, college or more), and marital status. Each race-sex specific group uses its respective quintile 2 as the reference *indicates $p<0.05$ for comparison to quintile 2; p for linear trend above quintile 2 is p=0.08 (White men); 0.95 (Black men); 0.20 (White women); 0.30 (Black women); p for Race-BMI interaction: 0.12 (men) and 0.03 (women)

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Table 1

Baseline Sociodemographic, Health Behavior, and Clinical Characteristics of 32,975 Never Smokers Aged 35 to 75 without Heart Disease or Cancer by BMI Quintile, National Health Interview Survey, 1997–2002

	BMI (kg/m^2)					
	Q1	**Q2**	**Q3**	**Q4**	**Q5**	**All Quintiles**
	< 23	**23.0 – 24.9**	**25.0 – 27.4**	**27.5 – 30.9**	**≥ 31.0**	
Sample Size	6,740	5,356	7,377	6,354	7,148	32,975
Age, mean (SE)	48.2 (0.15)	49.5 (0.16)	49.7 (0.14)	49.7 (0.16)	49.3 (0.13)	49.3 (0.07)
Age group						
35–49	63	58	57	57	57	58
50–64	25	28	30	30	32	29
65–75	12	14	13	13	11	13
Male	21	43	56	54	42	43
White	93	90	88	84	79	87
Black	7	10	12	16	21	13
Educational Attainment						
<High school	26	30	31	32	36	31
High school graduate	5	6	7	9	11	8
Some college	26	26	27	28	30	27
≥College	43	38	35	31	23	34
Marital Status						
Married/Living with Partner	73	73	74	73	67	72
Divorced/widowed/separated	17	18	18	18	21	18
Never married	10	9	8	9	12	10
Income Below Poverty Level	5	4	4	5	8	5
Health Behaviors						
Alcohol Drinking						
Current	25	24	24	26	30	26
Former	10	12	13	14	17	13
Never	65	64	63	60	53	61
Leisure-time physical activity						
Inactive	27	29	31	33	43	33
Low	35	34	34	35	30	34
High	38	37	35	32	27	33
Clinical Characteristics						
BMI (kg/m^2), mean (SE)	21.1 (0.02)	24.0 (0.01)	26.2 (0.01)	29.2 (0.01)	35.6 (0.06)	27.4 (0.04)
Hypertension (yes)	12	17	22	31	44	25
Diabetes (yes)	2	2	4	6	13	5

All results are percentages (except where indicated) and are weighted to reflect the general US population. SE indicates standard error

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Table 2

Baseline Sociodemographic, Health Behavior, and Clinical Characteristics of 38,700 Ever Smokers Aged 35 to 75 without Heart Disease or Cancer by BMI Quintile, National Health Interview Survey, 1997–2002

	BMI (kg/m^2)					
	Q1	**Q2**	**Q3**	**Q4**	**Q5**	**All Quintiles**
	< 23	**23.0 – 24.9**	**25.0 – 27.4**	**27.5 – 30.9**	**≥ 31.0**	
Sample Size	8,570	6,523	8,893	7,405	7,309	
Age, mean (SE)	49.6 (0.13)	50.7 (0.14)	51.4 (0.13)	51.4 (0.15)	51.0 (0.14)	50.8 (0.07)
Age group						
35–49	57	52	49	48	48	51
50–64	29	33	36	37	39	35
65–75	14	14	15	15	13	14
Male	35	54	66	68	56	56
White	93	91	89	85	80	87
Black	9	10	11	13	16	13
Educational Attainment						
<High school	37	37	37	38	39	38
High school graduate	15	13	13	15	17	14
Some college	28	28	29	29	29	28
≥College	20	22	21	19	15	19
Marital Status						
Married/Living with Partner	72	73	74	73	67	72
Divorced/widowed/separated	18	18	18	18	20	18
Never married	10	9	8	9	13	10
Income Below Poverty Level	10	8	6	7	10	8
Health Behaviors						
Alcohol consumption						
Current	9	8	8	9	10	9
Former	18	18	19	21	25	20
Never	73	74	73	69	65	71
Leisure-time physical activity						
Inactive	40	35	36	38	45	39
Low	27	30	30	30	28	29
High	33	36	34	32	26	32
Clinical Characteristics						
BMI (kg/m^2), mean (SE)	21.0 (0.02)	24.0 (0.01)	26.2 (0.01)	29.2 (0.01)	35.3 (0.06)	27.1 (0.03)
Hypertension	15	22	26	33	44	28
Diabetes	3	4	6	8	15	7

All results are percentages (except where indicated) and are weighted to reflect the general US population. SE indicates standard error

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Table 3

Baseline Sociodemographic, Health Behavior, and Clinical Characteristics of 32,975 Never Smokers Aged 35 to 75 without a History of Heart Disease or Cancer, by Race and Sex, National Health Interview Survey, 1997–2002

	White men	Black men	p-value	White women	Black women	p-value	Total
Sample Size	11,123	1,861		16,037	3,954		32,975
Age in years, mean (SE)	47.5 (0.11)	46.7 (0.30)	0.731	50.9 (0.11)	49.3 (0.24)	<0.001	49.3 (0.07)
Age group							
35–49	65	69		52	58		59
50–64	27	23		32	28		29
65–75	8	9	0.136	16	14	<0.001	13
Educational Attainment							
<High school	26	37		34	34		31
High school graduate	5	14		7	19		8
Some college	26	29		28	29		27
≥College	43	20	<0.001	31	18	<0.001	33
Marital Status							
Married/Living with Partner	77	62		74	43		72
Divorced/widowed/separated	12	20		20	39		18
Never married	11	19	<0.001	6	19	<0.001	10
Income Below Poverty Level	3	9		4	20		6
Health Behaviors							
Alcohol Drinking							
Current	17	28		29	49		26
Former	13	18		12	17		13
Never	70	54	<0.001	59	34		61
Leisure-time physical activity						<0.001	
Inactive	28	41		33	52		34
Low	35	29		34	26		33
High	37	30	<0.001	33	22	<0.001	33
Clinical Characteristics							
BMI (kg/m^2), mean (SE)	27.8 (0.05)	29.0 (0.14)	<0.001	26.5 (0.06)	29.8 (0.13)	<0.001	27.4 (0.04)
Hypertension	22	32	<0.001	25	41	<0.001	25
Diabetes	5	8	<0.001	5	12	<0.001	6

All results are percentages (except where indicated) and are weighted to reflect the general US population. SE indicates standard error

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Table 4

Age-standardized All-cause Mortality Rates (per 1,000 person-years) and Excess Deaths by Race and Body-Mass Index Quintile in 32,975 Never Smokers Without Heart Disease or Cancer at Baseline through 2006

	Black men (n=1,861) BMI Quintile (kg/m^2)				
	< 23.0	**23.0 – 24.9**	**25.0 – 27.4**	**27.5 – 30.9**	**≥ 31.0**
Deaths, n	20	13	28	15	43
Population, N	158	238	493	361	611
Person-years of follow-up	978	1,515	3,205	2,977	3,068
Death rate*					
Per 1000 p-yrs (CI)	176.0 (89.9 – 262.2)	75.8 (29.6 – 122.0)	77.6 (48.1 – 107.0)	85.3 (48.2 –122.4)	71.7 (41.2 – 102.3)
Excess deaths (own ref)	100.2	-	1.8	9.5	- 4.1
Excess deaths (WM ref)	137.8	37.6	38.4	47.1	33.5

	White men (n=11,123) BMI Quintile (kg/m^2)				
	< 23.0	**23.0 – 24.9**	**25.0 – 27.4**	**27.5 – 30.9**	**≥ 31.0**
Deaths	52	55	95	77	95
Population	1,202	1,882	3,294	2,632	2,113
Person-years of follow-up	7,866	12,273	21,232	16,929	13,171
Death rate*					
Per 1000 p-yrs (CI)	72.9 (53.3 – 92.5)	38.2 (26.3 – 50.1)	42.7 (32.5 – 52.9)	38.6 (28.5 – 48.7)	67.6 (50.7 – 84.6)
Excess deaths (own ref)	34.7	-	4.5	0.4	29.4
Black-White Difference	103.1	37.6	34.9	46.7	4.1
Black-White Ratio	2.41	1.98	1.82	2.21	1.06

	Black women (n=3,954) BMI Quintile (kg/m^2)				
	< 23.0	**23.0 – 24.9**	**25.0 – 27.4**	**27.5 – 30.9**	**≥ 31.0**
Deaths	26	26	19	52	80
Population	493	494	692	853	1,422
Person-years of follow-up	3,148	3,200	4,527	5,448	8,883
Death rate*					
Per 1000 p-yrs (CI)	94.2 (51.9 – 136.5)	91.5 (54.7 – 128.4)	34.4 (16.6 – 52.2)	65.6 (43.0 – 88.2)	62.5 (47.8 – 77.1)
Excess deaths (own ref)	2.7	-	−57.1	−25.9	−29.0
Excess deaths (WW ref)	68.2	65.5	8.4	39.6	36.5

	White women (n=16,037) BMI Quintile (kg/m^2)				
	< 23.0	**23.0 – 24.9**	**25.0 – 27.4**	**27.5 – 30.9**	**≥ 31.0**
Deaths	129	67	101	87	125

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	White women (n=16,037)				
	BMI Quintile (kg/m^2)				
	< 23.0	**23.0 – 24.9**	**25.0 – 27.4**	**27.5 – 30.9**	**≥ 31.0**
Population	4,887	2,742	2,898	2,397	3,113
Person-years of follow-up	31,955	17,842	18,860	15,557	19,715
Death rate*					
Per 1000 p-yrs (CI)	36.1 (28.7 – 43.6)	26.0 (19.7 – 32.4)	31.0 (24.9 – 37.2)	36.3 (29.1 – 43.6)	43.2 (35.2 – 51.1)
Excess deaths (own ref)	10.1	-	5	10.3	17.2
Black-White Difference	58.1	65.5	3.4	29.3	19.3
Black-White Ratio	2.61	3.52	1.11	1.81	1.45

* Age-standardized by the direct method with 3 age categories (35–49; 50–64; 65–75 years) and the 2000 US Census as the standard; CI=confidence interval; MR=Mortality rate; excess death rates determined by comparing death rate with reference death rate category of 22.84–25.09 for 1) race-sex specific group or 2) the sex-specific White category. WM=White men; BM=Black men; WW=White women; BW=Black women; ref=reference; own ref=each race-sex specific group uses its respective quintile 2 as the reference